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INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for September, 1888, and is based upon reports of regular and voluntary observers of both countries.

On chart i the paths of the centres of nine areas of low pressure are shown; the average number for September during the last fifteen years being 9.3.

Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their approximate paths shown on chart i, on which also appear the distribution of icebergs and the limits of fog-belts west of the fortieth meridian.

The West Indian hurricane of the 1st-7th, and the severe storm which occurred over mid-ocean during the first half of the third decade of the month, ~~as shown~~ with the heavy rains and gales in the south Atlantic and east Gulf states from the 7th to the 10th, inclusive, constituted noteworthy meteorological features for September, 1888. Fog was less frequently encountered along the trans-Atlantic routes than in the preceding month, and the eastern limit of the Arctic ice-field was largely contracted when compared with the average for corresponding months of previous years.

The distribution of mean temperature is shown on chart ii by dotted isothermal lines.

The month was warmer than the average September over the western part of the country, the maximum temperatures being the highest recorded in the Saskatchewan and middle Sacramento valleys, and in portions of the extreme north-western states and territories. Over the eastern part of the United States the mean temperature was below the normal, and in states lying south of the Great Lakes and the Saint Lawrence River the minima fell below those of previous years.

The distribution of rainfall for September, 1888, is exhibited

on chart iv, and the normal precipitation for eighteen years is shown on chart v.

The rainfall was deficient over a greater part of the country west of the Atlantic coast states. In the south Atlantic and east Gulf states the abnormally heavy rainfalls of the early portion of the month occasioned destructive freshets and caused considerable damage to crops.

Chart vi shows lines of equal annual depth of evaporation, in inches, based upon observations taken from July, 1887, to June, 1888, inclusive.

Commencing with July, 1888, the meteorological means for stations of the Signal Service have been determined from two daily observations taken at 8 a. m. and 8 p. m. (75th meridian time). These hours of observation have been permanently adopted, to supersede the former system of tri-daily observations taken at eight-hour intervals.

In the preparation of this REVIEW the following data, received up to October 20, 1888, have been used: the regular bi-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 19 Canadian stations, as telegraphed to this office; 178 monthly journals and 185 monthly means from the former and 19 monthly means from the latter; 364 monthly registers from voluntary observers; 71 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New England, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, and Tennessee, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for September, 1888, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on chart ii by isobarometric lines. On July 1, 1888, the tri-daily observations of the Signal Service were superseded by observations taken bi-daily at the hours named. A protracted series of hourly observations has shown that the difference between the mean pressure obtained from two observations taken at these hours and that determined from tri-daily observations, taken at eight-hour intervals, is so small as to be practically inappreciable.

The mean pressure for September, 1888, was highest over the central and east-central portions of the country, where it rose, in localities, above 30.10, and reached a maximum of 30.12 at Lamar, Mo. The area of lowest mean pressure occupied the lower Colorado valley, where the values fell to

29.76 at Yuma, Ariz. The barometric gradients were steep over the extreme west-central and southwest districts, notably in northern California and southern Arizona; elsewhere they were gentle.

As compared with the pressure chart for August, 1888, a general increase is shown, except over the south Atlantic and east Gulf states, in the middle Saskatchewan valley, and along the Pacific coast. The greatest increase has occurred over eastern New England and the Canadian Maritime Provinces where it exceeds .15 inch, and in the middle Missouri valley and over portions of the middle and southern slope of the Rocky Mountains where it is more than .10 inch. In the regions of decrease the changes have been small, except over Florida where they exceed .05 inch.

As compared with the normal pressure for September, the mean barometer readings for the current month were above the

normal over New England, the Canadian Maritime Provinces (except over the western extremity of Nova Scotia), along the Saint Lawrence Valley, and, generally, over the Great Lakes and over the entire central portion of the country; the greatest departures occurring in the upper Missouri valley and over the northern and middle slopes of the Rocky Mountains, where they varied from .06 to .10 inch. The mean pressure was deficient along the Atlantic coast south of New England, and in all states lying south of the Ohio and east of the Mississippi rivers, and in Louisiana. It was also below the normal over the extreme western part of the country from British Columbia to Mexico. The greatest departures below the normal occurred in the middle Sacramento valley, where they amounted to .10 inch, and along the middle Atlantic coast, where they were more than .05 inch.

BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The ranges conform to the general rule, that is they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. Along the Atlantic coast the extreme ranges varied from .42 at Key West and .41 at Sanford, Fla., to 1.53 at Nantucket, Mass., and 1.50 at Eastport, Me.; between the eighty-second and ninety-second meridians, .43 at Pensacola, Fla., to 1.03 at Alpena, Mich.; between the Mississippi River and Rocky Mountains, .29 at Brownsville, Tex., to .89 at Saint Vincent, Minn.; in the plateau and Rocky Mountain regions, .37 at Yuma, Ariz., to 1.02 at Fort Assinaboine, Mont.; on the Pacific coast, .33 at San Diego, Cal., to .74 at Port Angeles, Wash.

AREAS OF HIGH PRESSURE.

Eight areas of high pressure were observed during the month of September, five of which originated to the east of the Rocky Mountains and passed eastward to the Atlantic coast, the remaining three being first observed on the north Pacific coast and disappearing in the Rocky Mountain region or to the north of Manitoba. The movement of the high areas on the Pacific coast was first to the north of east and, after passing the coast line, to the southeast, until they finally disappeared in the central Rocky Mountain region or changed direction to the north of east after reaching the one hundred and tenth meridian. Three of these areas apparently developed over the central Rocky Mountain slope or in the central valleys, each of which moved northeastward over the Lake region, after which the direction changed to the south of east and they crossed the Saint Lawrence Valley and northern New England and disappeared to the east of Nova Scotia.

The following table shows the approximate latitude and longitude in which the centre of each area of high pressure was first and last observed, the highest observed barometer reading attending each, and the average rate of movement in miles per hour:

Number of area.	First observed.		Last observed.		Highest observed barometer reading.	Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
I.....	39 00	103 00	44 00	59 00	30.32	34.7
II.....	41 00	103 00	41 00	61 00	30.68	25.0
III.....	51 00	99 00	43 00	61 00	30.40	21.3
IV.....	46 00	122 00	50 00	94 00	30.36	18.8
V.....	46 00	123 00	38 00	105 00	30.32	16.7
VI.....	43 00	90 00	43 00	70 00	30.42	13.9
VII.....	42 00	127 00	42 00	104 00	30.60	17.7
VIII.....	51 00	112 00	34 00	87 00	30.54	20.8

Average rate of progress, 21.1 miles per hour.

I.—On the morning of September 1st areas of low pressure were observed on the New England coast, in the lower Mississippi valley, and to the north of Lake Superior, while the pressure was high over the Missouri Valley and central Rocky Mountain region. The succeeding twenty-four hours showed

a slight easterly movement of the area of high pressure over the central valleys, and during the 2d the easterly movement was more rapid, carrying the centre of greatest pressure to the Saint Lawrence Valley. It passed over northern New England, and the maximum pressure, 30.32, occurred on the morning of the 4th at Sydney, N. S., after the centre had apparently passed to the eastward of that station.

II.—Number ii appeared over the eastern slope of the Rocky Mountains on the 4th, when the preceding area of high pressure was passing off the North Carolina coast; it moved over the same general course followed by number i, extending over the upper lake region on the 5th, and over the Saint Lawrence Valley on the 6th, where the direction of movement changed to the southeast. Although the general direction of movement of this high area was almost identical with that of number i both as to direction and rate of movement, the latter was more clearly defined, owing to the rapid increase of pressure during the easterly movement. When first observed it was bounded by an isobar of 30.2, and when last observed central over New England the pressure had increased to 30.68. The usual fair weather attending areas of high pressure prevailed over the Northern States and central valleys during the greater part of the period from the 1st to 8th, and damaging frosts occurred in New England on the 6th and 7th while high area number ii covered that region. The northeasterly winds in the Southern States attending the transit of these areas were generally accompanied by cool, threatening weather and rain during the period named. The rains in the Southern States were also partially due to the tropical storm passing to the south of the stations of observation, the distribution of pressure tending to keep the winds within the rain quadrants.

III.—This area of high pressure appeared to the northward of Manitoba on the afternoon of the 11th, and after passing almost directly to the southward of Iowa during the succeeding twenty-four hours, it changed direction to the eastward, and by the afternoon of the 14th it was central off the middle Atlantic coast. It was attended by killing frosts in portions of Michigan and Wisconsin, and light frosts in the Ohio Valley on the 13th. The frosts in the tobacco and cranberry regions of Wisconsin caused some damage to these crops. A warning was telegraphed from this office on the evening previous to the occurrence of these frosts, but owing to imperfect telegraphic facilities the dispatches were not received by interested parties in time to enable them to take advantage of the warnings. Light frosts also occurred in portions of New England and the middle Atlantic states during the passage of this area of high pressure. After reaching the middle Atlantic coast this high area apparently extended in north and south directions, the centre passing to the New England coast and thence eastward, being last located to the southeastward of Nova Scotia on the 16th. The maximum barometric pressure observed within the limits of this high area, 30.40, occurred at Huron, Dak., on the morning of the 12th, when the centre was near that station, this reading being .10 higher than the pressure at the centre of the area when it was last observed.

IV.—Number iv apparently formed on the north Pacific coast on the 13th, during which date it passed from the southern to the northern portions of Washington Territory. The pressure increased rapidly during the succeeding twenty-four hours as it passed southeastward, covering the Rocky Mountain regions during the 14th and morning of the 15th, the maximum pressure, 30.36, occurring at Cheyenne, Wyo., on the morning of the 15th, when the area was elliptical in form and was bounded by isobars of 30.3, 30.2, and 30.1, extending from Montana and Idaho southward to Texas and New Mexico. The succeeding reports indicate that portions of this area of high pressure moved northeastward, attended by decreasing pressure at the centre, and it probably disappeared to the north of Minnesota, or formed a part of the more extended area of high pressure which covered the Hudson Bay region and lower Saint Lawrence valley on the 17th.

V.—Number v appeared off the Pacific coast west of Oregon

on the morning of the 18th. It passed directly eastward over the northern plateau region and thence southeastward over the central Rocky Mountain region, where it disappeared on the 21st by a gradual decrease of pressure, and without causing marked disturbances, although light rains occurred generally at Rocky Mountain stations after the winds shifted to northerly, and during the increase of pressure attending this area. The maximum pressure, 30.32, occurred at Cheyenne, Wyo., on the morning of the 20th.

VI.—This area of high pressure formed in the upper Mississippi valley on the 20th, when the preceding area covered the Rocky Mountain region, the two areas of high pressure being separated by a trough of low pressure covering the Missouri Valley. It moved slowly northeastward and was apparently re-enforced from the Hudson Bay region, the barometer reaching its maximum, 30.42, at LaCrosse, Wis., on the morning of the 23d. It remained almost stationary from the 20th to 23d, after which it moved eastward to the New England coast, the pressure decreasing from 30.42 to 30.20 during the easterly movement, and it disappeared rapidly on the 25th, in advance of the tropical storm which was then moving along the Atlantic coast.

VII.—This area of high pressure was observed on the 21st to the west of northern California, and moved slowly northeastward until the afternoon of the 23d, when it was central in northwestern Washington Territory. It moved rapidly eastward over the northern plateau region, the pressure attaining its maximum, 30.60, in western Montana on the 24th, after which it apparently extended southward, covering the eastern Rocky Mountain slope, but disappearing by a decrease of pressure before reaching the central valleys.

VIII.—The preceding area was followed quickly by the appearance of a second area of high pressure to the north of Montana, while number vii extended over the central Rocky Mountain region. The high area northward of Montana moved southeastward, covering the eastern slope of the Rocky Mountains on the morning of the 27th. The succeeding twenty-four hours shows that this area drifted to the eastward, covering the central valleys, from the Gulf to Manitoba, the maximum pressure observed being 30.54 at Cheyenne, Wyo., although the general circulation of the winds indicated that the centre of this high area was in the lower Missouri valley. Killing frosts occurred throughout the Northwest on the 29th, and light frosts in the Ohio Valley and northern portions of the Gulf and south Atlantic states on the 30th. After reaching the central valleys this area apparently drifted to the southeastward, passing over the Southern States, where it remained at the close of the month.

AREAS OF LOW PRESSURE.

The following table shows the latitude and longitude in which each area of low pressure was first and last observed, the lowest pressure observed within each area, and the average velocity in miles per hour:

Number of area.	First observed.		Last observed.		Lowest observed barometer reading.	Average velocity per hour.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
I.....	42 °	72 °	44 °	67 °	29.74	25.0
II.....	32 °	114 °	51 °	64 °	29.60	28.6
III.....	26 °	115 °	52 °	77 °	29.48	16.7
IV.....	26 °	80 °	51 °	59 °	29.50	16.0
V.....	53 °	114 °	51 °	59 °	29.46	25.0
VI.....	40 °	89 °	45 °	87 °	29.64	5.6
VII.....	27 °	79 °	50 °	65 °	29.08	33.3
VIII.....	00 °	107 °	49 °	66 °	29.42	30.6
IX.....	52 °	98 °	48 °	91 °	29.46	36.7

Average rate of progress, 24.2 miles per hour.

Nine areas of low pressure were observed within or near the stations of observation during the month of September. This number, however, does not include the West Indies hurricane

which passed over Cuba and the southern portion of the Gulf of Mexico during the earlier part of the month, and which is described as number i under the heading "North Atlantic storms." It will be seen from chart i that the mean track of the areas of low pressure traced for this month was to the eastward generally to the north of the stations of observation, while two disturbances were traced along the Atlantic coast from Florida to the lower Saint Lawrence valley.

The following are general descriptions of the weather conditions attending each area of low pressure:

I.—The month opened with an area of low pressure of slight energy central over New England and an area of high pressure covering the eastern slope of the Rocky Mountains and the central valleys. This disturbance moved northeastward, causing heavy rains in northern New England on the 1st, and it apparently disappeared over the Maritime Provinces by a gradual increase of pressure. The lowest barometer reading observed was 29.74, at Manchester, N. H., on the 1st.

II.—Area of low pressure number ii appeared to the north of Montana on the afternoon of the 1st, the pressure being low over the plateau region from British Columbia southward to Arizona. This disturbance moved directly eastward, following the general course of the fiftieth parallel of latitude, the pressure at the centre apparently increasing until the disturbance passed eastward of the Lake region, after which the pressure declined slightly and the area apparently extended. Although this disturbance caused no marked change in the weather conditions its movement eastward could be traced from the weather charts from the 1st until the morning of the 5th when it was central north of the Gulf of Saint Lawrence. The minimum pressure observed was 29.60 at Calgary, Northwest Territory, on the 1st.

III.—This area of low pressure appeared on the afternoon of the 5th in the same region where the preceding area was first observed, and was attended by similar distribution of pressure over the western portion of the continent. The barometric trough extended from British Columbia southward over the plateau regions, and the pressure was high over the eastern slope of the Rocky Mountains and in the central valleys. These conditions drifted to the eastward during the succeeding twenty-four hours, the barometric trough covering the Rocky Mountain regions and the centre of disturbance moving southeastward to western Dakota, the barometric pressure, however, increasing within the centre about .20. After reaching Dakota on the afternoon of the 5th the storm apparently moved to the northeastward, attended by light rain in its southern quadrants, which covered the Northwest and upper lake region. When this disturbance changed its course to the northeast in Dakota on the 5th, a severe tropical storm was passing westward over the southern portion of the Gulf of Mexico. The northeasterly movement of this storm continued until the 7th, when its course changed to the eastward, the centre being approximately located far to the north of the Lake region during the 7th and 8th, and it disappeared to the east of Hudson Bay on the 9th. The westerly winds following this storm attained maximum velocities of thirty-five miles per hour on Lakes Huron and Michigan. The lowest observed pressure was 29.48 at Calgary, Northwest Territory, on the 4th.

IV.—This was a well defined tropical storm which was first observed near Point Jupiter, Fla., on the afternoon of the 7th; it moved slowly northwestward, recurving near latitude 30° in the vicinity of Cedar Keys, Fla. during the night of the 8th, attended by violent winds on the east and west Florida coasts, the wind attaining a maximum velocity of sixty miles per hour at Cedar Keys, where the barometer fell to 29.50. The centre of this storm moved to the east of north over the south Atlantic states, attended by very heavy rains and dangerous gales along the coast. At the afternoon report of the 10th it was central near Norfolk, Va., after which it followed the middle Atlantic and New England coasts, causing dangerous gales as far north as Boston. After reaching the southern New England coast it moved directly northward to the Saint Lawrence

Valley, forming a junction with the low area traced as number v, after which the single disturbance moved northeastward with an apparent loss of energy and disappeared to the northeastward on the 14th. The lowest pressure observed was that noted at Cedar Keys, Fla., on the afternoon of the 8th.

V.—Number v originated north of Montana on the 8th when the general distribution of pressure was similar as described in the cases of low areas numbers ii and iii, and it followed a corresponding path to the eastward, nearly coincident with the fiftieth parallel, inclining first to the south of east, and causing secondary depressions of slight energy to form in the Northwest and Rocky Mountain regions, while the centre of the principal disturbance remained to the north of the stations of observation. It passed north of the Lake region during the 11th and apparently attained its maximum energy when the centre was north of Lake Superior. When the disturbance approached the Saint Lawrence Valley it was apparently drawn toward the tropical storm which was then moving along the Atlantic coast, and the two storms united, as previously stated, when near Quebec. The angle made by the direction of these tracks previous to their union was about 70°, and the direction of movement after the union was approximately a continuation of the path of the tropical storm. Each storm was deflected from its course as the centres approached the point of union. The lowest barometer reading observed during the passage of number v was 29.46 at Medicine Hat, Northwest Territory, on the afternoon of the 9th.

VI.—This disturbance developed in the central Mississippi valley on the 15th within an extended barometric trough which resulted from an area of low pressure which was first observed over the plateau regions on the 11th. The early movements of this depression were not traced, owing to the uncertainty as to the positions of its centre. A barometric disturbance formed on the 12th to the north of Montana and moved eastward to the north of the stations of observation, in a manner similar to that described in low areas numbers ii, iii, and v. Secondary disturbances formed in the Missouri Valley on the 13th, which were attended by high northerly winds in the states and territories of the Missouri Valley. After the barometric trough reached the central valleys on the 15th the pressure apparently increased at the northerly stations and a secondary disturbance formed to the southward, which has been traced as number vi. Heavy rains occurred from the Gulf States northward over the Lake region, and during the first twelve hours the direction of movement of this area of low pressure was to the northeast from Illinois to Michigan, after which it apparently moved slowly westward for thirty-six hours, carrying the centre of disturbance to the southern portion of Wisconsin, from which point it moved slowly northward and disappeared by an increase of pressure during the afternoon of the 18th. An ex-

amination of the weather charts shows that there was a well-defined movement of this disturbance to the westward on the 16th and 17th. A minimum pressure of 29.64 was observed at Grand Haven, Mich., on the 16th.

VII.—The marine reports received at this office indicate that this storm originated east of and near the Florida coast on the 24th. It moved rapidly northward, passing from the latitude of northern Florida to southern New England in twenty-four hours. Reports received from Hatteras, N. C., indicate that the centre passed to the east of, and near, that station on the afternoon of the 25th, while on the morning of the 26th the centre had reached the vicinity of Nantucket, where dangerous gales were reported, the wind reaching a velocity of 60 miles northeast at Block Island, and 50 miles southeast at Nantucket, Mass. On the southern New England coast the barometer fell .78 in twelve hours, and reached a minimum of 29.08 at Nantucket on the morning of the 26th. By 8 p. m. of that date the centre had reached the vicinity of Eastport, Me., and the wind attained a maximum velocity of 60 miles per hour at both Boston and Eastport during that day. It will be seen from the table of velocities, etc., that this storm moved at an unusually rapid rate, and it probably passed beyond the stations northeast of New England during the 27th.

VIII.—This storm appeared in the region to the north of Montana on the 25th and moved southeastward during the next forty-eight hours, reaching the vicinity of Lake Huron where it attained its maximum energy, being attended by brisk to high westerly winds throughout the Lake region. At this point the course changed in the direction of the Saint Lawrence Valley, the centre of disturbance extending rapidly and the pressure increasing with the easterly movement. It was last marked central in the vicinity of Father Point, Quebec, on the morning of the 28th. The lowest barometer reading, 29.42, was observed at Sault Ste. Marie, Mich., on the morning of the 26th.

IX.—This storm was central north of Manitoba on the morning of the 30th and it moved rapidly southeastward, the centre reaching the western portion of Lake Superior by 8 p. m. of that date, attended by general rains throughout the Lake region. The rapid fall of the barometer during the last twelve hours on the 30th indicated that this storm would increase rapidly in energy and cause severe gales on the lakes. While the morning report of the 30th did not justify the ordering of cautionary signals for the upper lake region, the conditions were sufficiently threatening to cause special reports to be called for, which were received in time to enable the central office at Washington to order cautionary signals several hours before the storm. The lowest barometer reading that had been observed before the close of the month was 29.46 at Marquette, Mich., in the afternoon.

NORTH ATLANTIC STORMS FOR SEPTEMBER, 1888.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that appeared over the north Atlantic Ocean during September, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Nine depressions have been traced, of which three advanced eastward from the American coast north of the fiftieth parallel; five apparently developed over mid-ocean, and one originated in the vicinity of the West Indies. One storm, which appeared over the Bahama Islands on the 6th and from thence moved north of west into the Gulf of Mexico, is traced and described as a land low area. The depressions whose paths are plotted in high latitudes generally pursued normal east-northeast tracks; over mid-ocean south of the fiftieth parallel the progressive movements of the storms were irregular, while over

the southern portion of the ocean the anomalous course of depression number 1 is an especially noteworthy feature.

In September, 1887, nine depressions were traced, of which five were of tropical or sub-tropical origin; three advanced eastward from the American continent north of the forty-fifth parallel, and one first appeared over the British Isles. The storms were generally deficient in energy, and while the depressions of tropical origin somewhat exceeded the average for the month, there was a corresponding decrease in the number that passed eastward near Newfoundland, and an almost entire absence of storms of pronounced strength in high latitudes east of the fortieth meridian.

In September, 1888, the disastrous hurricane which traversed the West Indies and the Gulf of Mexico from the 1st to the 7th, inclusive, and the severe storms which attended the presence of depressions located, respectively, over mid-ocean and